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Feature selection for chemical process fault diagnosis by artificial immune systems

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Abstract

With the Industry 4.0 era coming, modern chemical plants will be gradually transformed into smart factories, which sets higher requirements for fault detection and diagnosis (FDD) to enhance operation safety intelligence. In a typical chemical process, there are hundreds of process variables. Feature selection is a key to the efficiency and effectiveness of FDD. Even though artificial immune system has advantages in adaptation and independency on a large number of fault samples, antibody library construction used to be based on experience. It is not only time consuming, but also lack of scientific foundation in fault feature selection, which may deteriorate the FDD performance of the AIS. In this paper, a fault antibody feature selection optimization （FAFSO）algorithm is proposed based on genetic algorithm to optimize the fault antibody features and the antibody libraries' thresholds simultaneously. The performance of the proposed FAFSO algorithms is illustrated through the Tennessee Eastman benchmark problem.

Key words: artificial immune system, genetic algorithm, feature selection

1. Introduction

Industry 4.0, which is regarded as the fourth industrial revolution, aims at transforming today's factories into smart factories. The purpose of smart factories is to address and overcome the current challenges of shorter product lifecycles, highly customized products, enhanced work safety and stiff global competition[1]. For the chemical process industry, smart factories are expected not only to maximize the economic value of factories, but also to make the best management of processes to avoid safety incidents [2]. With the boom of science and technology, modern chemical plants are developing towards the direction of large-scale, complication and integration, which therefore increases the chance of mishaps and faults. Due to the flammable, explosive, toxic, and corrosive nature of chemical processes and the strong coupling between different parts of a production system, one partial failure may trigger the abnormality of the entire system through a chain of reactions, resulting in tremendous economic, social and/or environmental losses. Since chemical processes are generally of high risks especially when an independent protection layer fails, operation safety